

Application No. 08/588,407
GAU 1733
Filed June 6, 2000

AMENDMENT TO THE SPECIFICATION

With respect to the Examiner's previous comments, the continuing data is inserted as the first sentence.

INFLATABLE HEATING DEVICE

Related U.S. Patent Application

This is a continuation-in-part of Application No. 08/882,769, filed June 26, 1997, which is a continuation-in-part of Application No. 08/431,302 filed April 28, 1995.

Technical Field

The present invention generally relates to an inflatable heating device and method of forming the device. More particularly, the invention relates to an inflatable heating device which can be inflated by a pressurized fluid and heated via an electrically conductive, non-ferrous matrix within the device's composition. The device can be used to provide compaction and heat sufficient to influence a physical reaction in a material in contact with the device's exterior, such as heating, compressing and curing a hardenable resin used in the in-situ repair of damaged conduits such as underground sewer pipes, and other structures having tubular or other three dimensional curvature.

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With respect to the Examiner's previous comments, the specification is amended to provide a proper antecedent basis for Claim 18. The previous proposed reference to non-conductive fibers has been omitted. The paragraph beginning at line 28 of page 11 is amended as follows:

In the present invention, multiple compositions can be considered and formed into the module using the resistive heat generating capability of carbon fibers in the module itself. A rotating mandrel can be provided as the forming surface of the composite 205. If the module is to be used for a pipe repair procedure, the mandrel would be generally cylindrical in shape and have a diameter closely approximating the inside diameter of the pipe to be repaired (minus the thickness of the module materials and allowing for 10-15% expansion of the module). A fluorosilicone material is utilized as an internal surface due to its inherent impermeability and low vapor transmission properties. The heating grid of the module is preferably a non-ferrous material, and is more preferably constructed of carbon fibers. Carbon fibers, with their exceptional tensile strength, electrical conductivity and chemical inertness, are used as both the heat producing element and the reinforcement for the module 210. The heating element can include a plurality of wound fibers comprising of temperature tolerant fiber windings and electrically conductive, i.e., carbon fiber, windings. An outer layer of a fluorocarbon could also be used to protect and contain the carbon fibers as well as providing a highly resistant (both chemically and thermally) and resilient outer skin. Because of the fluoropolymer similarities, during the consolidation and forming on the mandrel, the uncured fluorosilicone and fluorocarbon materials are co-cured and bonded together to form a homogenous mass capable of resisting chemicals, abrasion and heat while maintaining flexibility.

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In response to the Examiner's previous comments that the non-ferrous heating element being carbon filaments or graphite filaments, the paragraph beginning at line 21 of page 7 is amended as follows (repeating two sentences originally appearing at line 21 of page 13 of the original disclosure):

With reference to Figure 2, the silicone matrix 202 used in the construction of the composite 205 is initially a pourable liquid, heat curable methylvinylpolysiloxane or other material having similar properties. The composite 205 is formed by applying the liquid silicone matrix 202 to pre-formed, braided composite fibers shown partially at 201. At least a portion of the fibers 201 should be conductive. Graphite fibers have been found suitable for this purpose. Carbon fibers, being low in mass and with a known conductivity will rapidly produce heat in a uniform manner. Because the electrical properties of carbon can be readily assumed, precise and uniform heating can be achieved. The non-ferrous heating element may therefore be of carbon or graphite filaments. For additional structural support, the composite fibers 201 may comprise a combination of graphite and fiberglass braids. The exact ratio of graphite to glass used will depend on the amount of structural strength contemplated as well as the heat generation capability desired. A composite found suitable for the present application consists of biaxial fiberglass braided sleeving with a weight of 10-20 oz./sq. yd. and biaxial carbon braided sleeving with a weight of 15-30 oz./sq. yd. The braid angle of these components is preferably +/- 45 degrees. It will be understood that other high-strength, temperature tolerant fiber braids may be substituted for the fiberglass and other electrically conductive fiber braids may likewise be substituted for the graphite. For example, conductive polymer coated nylon or polyester fiber, or a combination of many different conductive fiber braids may be used instead of graphite.